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EFFECT OF THE VERTICAL INHOMOGENEITY OF THE EARTH'S MAGNETIC FIELD ON THE HIGH FREQUENCY CHARACTERISTICS OF THE IONOSPHERE

by V. N. Kessenikh

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EFFECT OF THE VERTICAL INHOMOGENEITY OF THE EARTH'S MAGNETIC FIELD ON THE HIGH-FREQUENCY CHARACTERISTICS OF THE IONOSPHERE.

(Vliyaniye vertikal'noy neodnorodnosti zemnogo magnitnogo polya na vysotno-chastotnyye kharackteristiki ionosfery)

V Section of the IGY Program (Ionosphere) pp. 7 - 8,
Ionospherical Researches No. 6.
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by V. N. Kessenikh.

ABSTRACT

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Earlier considerations by the author concerning the effect on the parameters of the high-frequency curves of the ionosphere of the Earth's magnetic field's vertical inhomogeneity are further developed.

It is shown that the presence of a vertical gradient of the Earth's magnetic field intensity in the region of slow variation of electron concentration in the ionosphere may result in a notable change of the actual height corresponding to the critical frequency of the extraordinary ray.

Author

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COVER-TO-COVER TRANSLATION

Considerations on the effect of the vertical inhomogeneity of the Earth's magnetic field upon the parameters of ionosphere's high-frequency characteristics were earlier brought forth by the writer (see [1]).

By developing them further, we reach the conclusion that the presence of a vertical gradient of geomagnetic field's intensity H in the region of slow variation in the electron concentration of the ionosphere may lead to a marked change of the true height, corresponding to the critical frequency of the extraordinary ray.

Let us assume that the electron concentration varies near the maximum according to the parabolic layer law, so that the electron concentration N(h) depends on $z = h - h_0$ as

$$N(z) \simeq N_m\left(1 - \frac{z^2}{z_m^2}\right), \tag{1}$$

and let us consider that the gyromagnetic frequency f_H varies with the height z according to the linear law

$$f_H = f_{H_0}(1 - \beta z). \tag{2}$$

From the reflection condition at vertical incidence we obtain that there takes place at the height $h_0 + z$ a total reflection of the extraordinary wave for the operating freuency determined according to

$$f = \frac{f_H}{2} + \sqrt{\frac{f_H^2}{4} + N_m\left(1 - \frac{z^2}{z_m^2}\right)\frac{e^2}{\pi m}}. \tag{3}$$

Since the value f^0 of the extraordinary ray's critical frequency does not depend on the value f_H, and corresponds, in the assumption of (1) to $z = 0$, we may, taking into account (2), write (3) in the form

$$f = \frac{f_{H_0}}{2}\left[1 - \beta z + \sqrt{(1-\beta z)^2 + A\left(1 - \frac{z^2}{z_m^2}\right)}\right], \tag{4}$$

where

$$A = 4\frac{f^{0\,2}}{f_{H_0}^2} = \frac{4N_m e^2}{\pi m f_{H_0}^2}. \tag{5}$$

The apparent value of the extraordinary ray's critical frequency will correspond in the ionogram to the condition

$$\frac{\partial f}{\partial z} = 0, \tag{6}$$

where f is determined according to (4).

Let us designate by z^x the value z which is the radical of equation (6), and by f^x — the corresponding values f from (4). Resolving (6), we have

$$z^x = -\beta z_m^2 \delta, \tag{7}$$

where

$$\delta = \frac{1 + \sqrt{1 + A - \beta^2 z_m^2}}{A - \beta^2 z_m^2}. \tag{8}$$

Let us examine, whether or not, cases are possible when the values z^x , i.e. the shifts of the true height, will markedly exceed the ionogram's precision, i.e. they will be of the order of one kilometer.

According to published data [2 – 5], β has a mean value of the order of $2 \cdot 10^{-4}$ km^{-1}.

In the current system region of the E-layer, β may reach 10^{-3}km^{-1}. According to Chapman data [4], values $\beta \sim 3 \cdot 10^{-2}$km^{-1} may be expected in the current systems of aurora arcs' regions.

It follows from the aforesaid, that in the region of a plane maximum, when z_m may have the order of 100 km, and for $\beta \sim 10^{-3}$,

$$|z^x| \cong 0,1\, z_m \frac{1+\sqrt{A}}{A} \approx 0,1\ \frac{z_m}{\sqrt{A}}\,.$$

Admitting $f^o = 3$ Mc/s, $f_{H_o} = 1.5$ Mc/s, we obtain $A = 16$, $z^x = 2.5$ km, which corresponds to the limit of errors of standard ionograms.

For greater values β significant anomalies may appear in the ionograms' structure, which may erroneously be taken for the result of layer's fine structure appearance.

The expounded considerations allow the conducting of more detailed investigations of the effect upon the detailed course of the ionograms of current systems' magnetic fields in the E-region.

**** THE END ****

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